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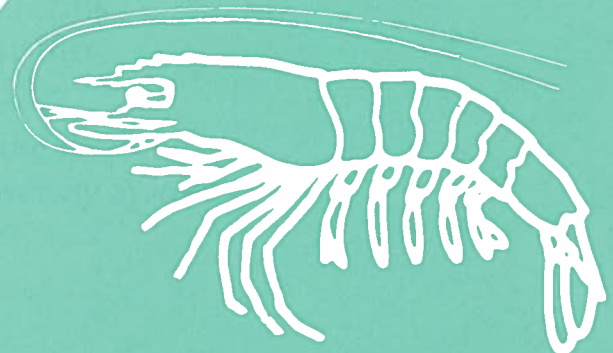
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Texas A&M University Sea Grant College Program

*This is the second in a series of information sheets on shrimp mariculture and its potential in Texas. This publication joins an earlier fact sheet, **Shrimp Mariculture: An Overview**. It will be followed by additional publications on permitting, maturation/reproduction, hatchery, pond grow-out, diseases and the economics of shrimp mariculture.*

*Upon completion, these information sheets will be compiled and published under one cover.*

# Shrimp Mariculture

State of the Art

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Shrimp is the most valuable U.S. fishery, yet nearly half of the shrimp consumed in this country since 1973 has been imported. The dockside value of shrimp imported for U.S. consumption was \$980 million in 1981, compared with domestic shrimp landings valued at \$509 million (79).

This imbalance has increased annually in the last decade, since the commercial harvest of marine shrimp is either at, or very near, maximum sustainable yield. The U.S. commercial catch has remained relatively constant since 1972 (Table 1), (69-78) while there has been a 20 percent per capita increase in the world's demand for fishery products. Demand is expected to increase even more, with some researchers predicting a 25 percent rise for foreign and domestic shellfish from 1975 to 1985 and a 33 percent increase for other fish (12).

Shrimp mariculture is emerging as a new agricultural industry for both developed and developing countries worldwide. Not only can it provide food for human consumption and bait for recreational fisheries, but shrimp culture also may provide seedstock to supplement natural populations.

Shrimp mariculture is the production of marine, or saltwater, shrimp under controlled environments in quantities for profit. It consists of three main phases—maturation and reproduction, hatchery (larviculture), and grow-out (Fig. 1). Seedstock, or larvae, are produced in the maturation and reproduction phase. This is accomplished by inducing female and male shrimp to mature, mate and spawn in captivity, producing live larvae. Shrimp larvae also can be obtained by "sourcing," or capturing mated and unmated mature females in their natural environment and spawning them in captivity.

The seedstock produced in the maturation and reproduction phase are used to supply the hatchery phase (larviculture). Larvae are reared to one-day-old postlarvae in approximately 10 to 12 days and to five-day-old postlarvae in 15 days. Five- to 10-day-old postlarvae (15- to 22-day-old shrimp) are used to supply the grow-out phase. The postlarvae are stocked into ponds, tanks or raceways and reared to food size (15- to 40-count, heads-on shrimp) in three to six months or bait size (60- to 100-count, heads-on shrimp) in two to three months.

In nature, marine shrimp reproduce and complete their larval development (nauplii, protozoa and mysis stages) in the open ocean (Fig. 2). After metamorphosing to a miniature adult form called postlarvae (7 to 15 mm total body length), they migrate into the bays and estuaries, where they stay until they reach juvenile size (usually 60- to 100-count, heads-on shrimp). Two to four months later, they migrate back into the ocean.

Depending on the species, juvenile shrimp become sexually mature when they are 5 to 8 months old (generally,

10- to 12-count, heads-on), with females being slightly larger than males at this time. This generally describes the life cycle of the native white shrimp, *Penaeus setiferus* (55,56,93), pink shrimp, *P. duorarum* (30,93), and brown shrimp, *P. aztecus* (27,93).

In nature, less than 1 percent of larvae survive to 20 to 25 gram (18 to 22 count heads-on) size. Commercial shrimp culture demands that this survival rate be increased to at least 20 percent.

## Role of Shrimp Mariculture

Shrimp mariculture can fulfill three roles:

- provide food for human consumption;
- provide bait for the recreational fishing industry; and
- provide seedstock to supplement natural populations.

The importance and productivity of shrimp mariculture for human consumption and its contribution to the economy of a developing nation has been clearly demonstrated in Ecuador. The value of farm-produced shrimp has increased from less than \$10 million in 1977 to nearly \$100 million per year in 1982. Considering that there is more investment capital available in the United States than in Ecuador, shrimp farming can be expected to develop even more rapidly in this country. The expertise and facilities required for processing, packaging, storing, transporting and marketing already are available, providing an added inducement for rapid commercialization.

Penaeid shrimp are used extensively for bait along the Gulf and southeastern Atlantic coasts. Texas, alone, has a wholesale bait fishery of about

Table 1: Shrimp landing, imports and value in the United States, 1972 through 1982

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
U.S. Commercial Shrimp											
Landings (Mil. lbs) <sup>1</sup>	235	229	226	209	246	288	257	206	208	219	176
Value (Mil. \$)	193	219	178	226	331	335	386	471	403	463	509
U.S. Imported Shrimp											
Million Pounds <sup>1</sup>	223	232	271	232	272	272	240	269	258	259	320
Value (Mil. \$)	250	282	387	346	463	492	422	713	719	724	980

<sup>1</sup>Landings and imports are heads-off. Also U.S. fishermen started being shared out of Mexican waters in 1977. Ten percent of Gulf of Mexico catch was from Mexican waters.

## MAJOR ASPECTS OF SHRIMP MARICULTURE

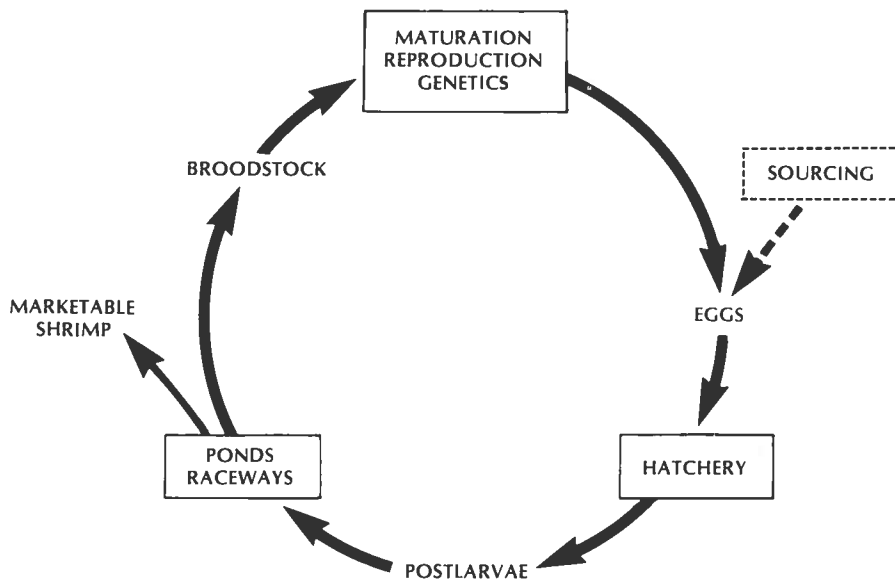


Figure 1

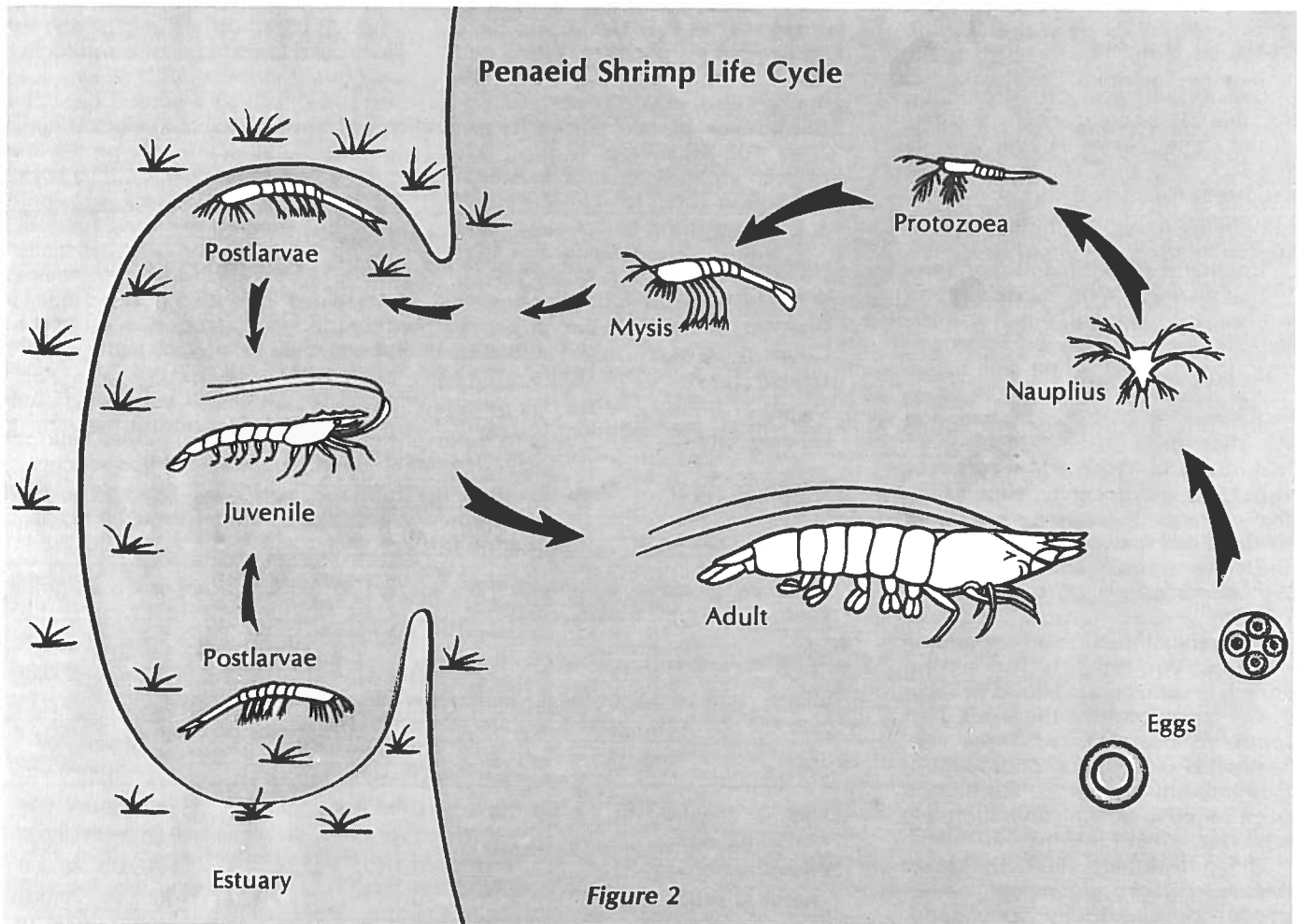


Figure 2

\$3 million per year. The two species used as bait along the Texas coast are *Penaeus setiferus* (white) and *P. aztecus* (brown). Although the brown shrimp is the most preferred of the two, white shrimp are a substitute when browns are unavailable. Pond production data for *P. setiferus* show that 80-count (5.67g) shrimp can be reared in eight to ten weeks, which would allow some two to three crops per year. Pond production data for *P. aztecus* have not been proven successful on a commercial level although the potential for this species as a cultured bait remains high.

It is possible to stock bays and estuaries with juvenile shrimp since two species of native shrimp (*Penaeus setiferus* and *P. aztecus*) can now be matured in captivity (50,18). Supplementing natural shrimp populations with cultured shrimp is already done successfully in the Seto Inland Sea of Japan (63,46), and a similar program has been initiated off the coast of Kuwait (2).

## State of the Art

The major obstacle preventing commercial shrimp mariculture either in the United States or worldwide is the lack of a predictable source of seedstock for the hatchery phase and, consequently, the limited availability of postlarvae for the grow-out phase.

The first maturation and reproduction of marine shrimp in captivity and subsequent rearing of larvae to marketable size in the United States was reported in 1980 using the native species *Penaeus setiferus* (50). Two non-native species, *P. vannamei* and *P. stylirostris*, have since been matured and spawned in captivity (19,23,24), and, recently, another native shrimp, *P. aztecus*, has been matured and spawned in captivity and the larvae reared to an average size of 2 g (approximately 225 count, heads-on) (18).

The general maturation and reproduction requirements for marine shrimp in captivity are shown in Table 2. The ranges indicate the levels used for the parameters listed. Three environmental parameters, photoperiod, light intensity and temperature, have been varied to obtain maturation and reproduction in captivity.

The nutritional requirements for penaeid shrimp maturation and reproduction are poorly understood,

even though nutrition is one of the most important factors. A single food source such as fish, mussels, mysid shrimp and squid (54,49,89,57,3,82,-23), a combination of two or more of these food sources or others such as polychaetes (9,11,97,20,44,10,23,24), or a combination of prepared dried feeds and frozen or fresh animals (5,7,90,32,50) have been used to obtain maturation, reproduction and spawning of marine shrimp with production of live shrimp larvae (nauplii) in captivity. At least two researchers have concluded that a combination of animal sources (squid, shrimp, polychaetes and clams) is better than a single-food diet (23). Unilateral eyestalk ablation also has been shown to enhance maturation and spawning with viable nauplii for *P. vannamei*, *P. stylirostris*, *P. merguensis*, *P. monodon* and *P. japonicus*.

Another important development has been the successful intraspecific crosses using artificial insemination with *P. vannamei*, *P. stylirostris* and *P. setiferus* (87,14,96). Using this technique for sourcing cruises could rep-

resent an economically feasible means of supplementing nauplii production to supply seedstock for commercial endeavors (13,14). Successful intraspecific crosses also provide a baseline for genetic selection studies, and artificial insemination will help solve problems of lack of mating and spermatophore loss in captivity and in studies on the quality of sperm and ova. Artificial insemination also produced the first known marine shrimp interspecific cross in 1982, when the Gulf of Mexico native white shrimp *Penaeus setiferus* was successfully mated with the Pacific Ocean blue shrimp *P. stylirostris* in Texas (51).

Table 3 summarizes the level of experimental spawning success for four species of marine shrimp that have been grown in ponds in the United States. The production of *P. stylirostris* larvae in captivity is considered adequate to support a commercial operation, although it is still inadequate for the three remaining species (41). The recent improvement in technology used to breed shrimp in captivity, the increased knowledge of reproductive

**Table 2: General requirements for maturation and reproduction of marine shrimp in captivity**

Parameter	
*Light Intensity	20 to 60 percent, variable
*Photoperiod	10 to 14 hours: 14:10 hours dark, variable
Water Quality	Oceanic
Water Exchange	5 to 150 percent depending upon presence of biofilters in tank
*Temperature	22°C to 28°C, variable
Salinity	26 to 34 ppt
Feeding Rate	3 to 5 percent dry weight of biomass per tank per day, depending upon size of animal and species
Source of Food	fresh or fresh-frozen, preferably from more than one source, e.g. squid, shrimp, marine worm, clam, marine fish

*\*Variance of these parameters are known to be important for maturation/reproduction in captivity.*

**Table 3: State of the art for the maturation and reproduction phase**

Species	Percent Spawning Per Day	Larvae Per Spawn
<i>Penaeus vannamei</i>	0.5-4.0	50,000-100,000
<i>Penaeus stylirostris</i>	3.0-6.0	60,000-140,000
<i>Penaeus setiferus</i>	0.1-1.0	20,000- 80,000
<i>Penaeus aztecus</i>	0.1-1.0	5,000- 20,000

biology, and the advent of artificial insemination make the maturation and reproduction phase much less limiting and shrimp farming more feasible.

The hatchery, or larviculture, phase is considered adequate to support a commercial operation for the four species being considered for shrimp mariculture in the United States. This level generally is accepted to be about 50 percent survival from the newly hatched larvae (nauplius) to 5- to 10-day-old postlarvae in 15 to 22 days. The hatchery phase has not been developed to its optimum level, however, and several areas need improvement. For example, recent reports indicate a variability in the percentage of survival from the naupliar stage to 5-day-old postlarvae (53,98,88,10,66,68). This may be due to a number of factors, including larval quality (17,106,67,11,25,8), inconsistent seawater quality (28,65), or variable feeding regimen (109,45).

There is no single standard method for rearing penaeid larvae to postlarvae, although most people use 28 ppt (salinity), 28°C (temperature) and water as close to oceanic quality as possible. The development rate and general dietary requirements for rearing larvae (Table 4) were described by the pioneering work of Hudinaga in 1942. Different genera of diatoms and phytoflagellates have been used to rear marine larvae successfully: *Chaetoceros* (88,99,43); *Isochrysis* (64,109); *Nitzschia* (39,53,107); *Phaedactylum* (101,107); *Skeletonema* (29,17,67); *Tetraselmis* (11,108,66); and *Thalassiosira* (26,107,32). There is insufficient information to identify a

**Table 4: Development time and food preference for larviculture (hatchery phase)**

Stage	Time (days)	Food Primary	Food Secondary
Nauplii	2.0-3.0	None	None
Protozoa	3.5-5.0	Plant	Animal
Mysis	3.5-5.0	Animal	Plant
Postlarvae	5.0-7.0	Animal	None

single algal species, combination of species or feeding densities that give the best production results in the larviculture of marine shrimp. Furthermore, different dietary requirements for the various larval stages for different marine species are not taken into account (45). In spite of this variability in methods, and recognizing none is optimal, commercial hatcheries supporting successful grow-out ventures exist in Panama, Taiwan and Japan.

Pond culture of marine shrimp in the United States was pioneered by Lunz using *Penaeus aztecus*, *P. duorarum* and *P. setiferus* (58,59,60,61,62). He demonstrated that ponds could be used to produce shrimp for bait and food. Generally, the best production using single-phase pond systems is greater than 500 pounds per acre (561 kg/ha) (15,48,81,33,84,21,31,40,95,52), although a high of 1,941 pounds per acre (2,246 kg/ha) has been obtained (22). Two-phase pond systems, consisting of nursery and grow-out ponds, and three-phase systems, consisting of nursery, intermediate and grow-out ponds, have been used to produce 534 to 805 pounds per acre (600 to 904 kg/ha) in Alabama (102,103) and 1,833 pounds per acre (2,059

kg/ha) in Texas (85). Further, two crops per season have been reported, yielding 845 pounds per acre (949 kg/ha) in Alabama (102) and 2,094 pounds per acre (2,351 kg/ha) in Texas (52).

The preceding production values are from ponds fed and fertilized, but researchers in Louisiana and Texas have obtained 42 to 267 pounds per acre (47 to 300 kg/ha) and 218 pounds per acre (245 kg/ha), respectively, in unfed and unfertilized ponds (48,95). Further research has shown that shrimp production in unfed and unfertilized ponds rarely exceeds 200 pounds per acre (224 kg/ha), with yields being much higher in ponds receiving feed (16). Increased natural productivity, and, subsequently, increased shrimp production, has also been obtained by adding fertilizer to ponds (104,105,95). Researchers have theorized that the increased growth of brown shrimp, *P. aztecus*, in ponds containing dredged materials was due to greater natural productivity as compared to ponds without dredged material (92). They further concluded that dredged material containment areas are both biologically and economically feasible for penaeid shrimp culture (91). More recently, blue

**Table 5: Stocking density experiment using *Penaeus vannamei***

Stocking Density	Production (Harvest) Data			
	Percent Survival	Size (grams)	Pounds** Per Acre	Value (\$)*** Per Acre
15,000	73*	20.50*	494*	1,477*
30,000	42	19.74	548	1,639
45,000	88	14.65	1,270	3,010
67,000	89	14.91	2,036	4,825
102,000	73*	10.50*	1,722*	3,565*

\*Estimated values. Animals were stocked on June 30, 1982 at an average size of 2.93 g. Animals were harvested on October 4, 5 and 6. Producer level values as of October 1, 1982 (heads-on) were: 10.0 to 13.5 grams/animal, \$2.07/lb.; 13.6 to 15.8 grams/animal, \$2.37/lb.; 15.9 to 18.9 grams/animal, \$2.60/lb.; and 19.0 to 22.0 grams/animal, \$2.99/lb.

\*\*Pounds per acre and value (\$) per acre can be converted to kg/ha and value (\$)/ha by multiplying by 1.12 and 2.47 respectively.

shrimp (*P. stylirostris*) have been grown in ponds with natural productivity enhanced by mixing secondarily treated sewage with seawater (47).

In general, water from estuaries and bays with temperature and salinity ranges of approximately 22° to 31°C and 10 to 50 ppt, respectively, are adequate for commercial food production of *P. setiferus*, *P. vannamei* and *P. stylirostris* in ponds. The predictability of pond production for two species, *P. vannamei* and *P. stylirostris*, has improved considerably during the last two years. Table 5 indicates the pond production level obtained on an experimental basis at the Texas A&M University System Shrimp Mariculture Facility at Corpus Christi. More than 2,000 pounds of heads-on shrimp per acre (2,246 kg/ha) with an ex-vessel value of nearly \$5,000 per acre (\$12,355/ha) was obtained in an experiment completed October 1982.

The native white shrimp, *P. setiferus*, has been produced at a commercial level in Texas ponds. This latter accomplishment, as well as artificial insemination results and increased knowledge of the reproductive biology of *P. setiferus*, make this one of the three best species to be considered for commercial pond culture in the United States. *P. vannamei* and *P. stylirostris* are the two others.

While technology for the grow-out phase in ponds is adequate for commercial profitability, pond production can be further improved by using more optimal stocking densities (83), fertilization and feeding, formulated feeds, and water exchange rates.

## Economics of Shrimp Culture

The lack of production data from viable U.S. commercial shrimp culture facilities makes accurate economic analysis difficult. Although costs and returns data for various pond designs, facility sizes and production potentials can be generated, they cannot be substantiated without successful commercial production units. Certain economic considerations are useful as a guide or planning tool as long as the user recognizes that results are contingent on the assumptions set forth in development. Prices for fixed and variable inputs are representative of the South Texas coastal area and reflect normal operating procedures for aquaculture ventures of a given magnitude. Produc-

**Table 6: Assumptions for Table 7\*.**

	Best Case	Expected Case	Least Case
Number of acres	250	250	250
Number of hectares	101	101	101
Production (heads-off)			
Pounds/acre	1055	931	780
Kilograms/hectare	1185	1046	876
Days in Pond	210	196	182
Size of Shrimp (lbs) at Harvest (g)	0.071 32.18	0.062 27.97	0.051 23.07**
Price/lb (heads-off)	\$ 5.43	\$ 4.80	\$ 4.80
Price/kg (heads-off)	\$ 11.99	\$ 10.60	\$ 10.60
Initial Density/acre	40,000	40,000	40,000
Initial Density/hectare	98,800	98,800	98,800
Harvest Density/acre	22,302	22,384	22,716
Harvest Density/hectare	55,086	55,388	56,109
Percent Survival	55.7	55.9	56.8

\*The information contained in this table is based on Johns et al. (1983).

\*\*This case assumes a 25% less growth at 210 days.

**Table 7: Variable and fixed costs for several production potentials for *P. stylirostris*\***

	Best Case	Expected Case	Least Case
Gross Revenue	\$ 1,432,163	\$ 1,117,200	\$ 936,000
Variable Costs			
Seedstock	150,000	150,000	150,000
Feed	269,812	234,301	205,287
Labor	57,260	56,456	55,652
Other	73,285	73,157	73,033
Total	\$ 550,357	\$ 513,914	\$ 483,972
Fixed Costs			
Salaries	43,200	43,200	43,200
Depreciation	86,254	86,254	86,254
Interest	267,480	267,302	266,626
Other	20,268	20,268	20,268
Total Fixed Costs	\$ 417,202	\$ 417,024	\$ 416,348
Total Cost	\$ 967,559	\$ 930,938	\$ 900,320
Revenue Above Total Cost	464,604	186,262	35,680
Federal Income Tax	213,718	85,681	7,126
Revenue Above Total Cost and Federal Income Tax	250,886	100,581	28,544
Required Return to Owner Equity	\$ 88,101	\$ 88,101	\$ 88,101
Revenue Above All Cost	\$ 162,785	\$ 12,480	\$ 59,557
Break-even Price/lb	\$ 3.67	\$ 4.00	\$ 4.62
Break-even Price/kg	9.06	9.88	9.90
Production (lb/acre)	713	766	750
Production (kg/ha)	799	869	840
Revenue Above All Total Cost and Tax/acre	\$ 1,000	\$ 402	\$ 114
Revenue Above all Total Cost and Tax/hectare	\$ 2,477	\$ 993	\$ 282

\*The information contained in this table is based on Johns et al. (1983).

**Table 8: Amounts (in millions of pounds) and value (in millions of dollars) of shrimp imported into the United States from 1977 to 1982 by Ecuador, India, Mexico, Nicaragua and Panama**

		Year					
Country		1977	1978	1979	1980	1981	1982
Countries with significant shrimp mariculture in 1982							
Ecuador	Amounts	9	11	14	20	25	36
	Value	24	30	54	68	80	137
Panama	Amounts	10	9	12	14	16	18
	Value	28	28	50	46	55	61
Countries without significant shrimp mariculture in 1982							
India	Amounts	41	39	31	13	19	27
	Value	50	45	48	21	33	49
Mexico	Amounts	76	72	72	76	71	80
	Value	188	170	295	317	290	375
Nicaragua	Amounts	7	6	5	6	4	3
	Value	19	16	18	21	13	9

tion potentials for pond cultured *P. stylirostris* were derived from Texas A&M University agricultural economists (83), who developed growth curves based on empirical data (from Texas) and on the von Bertalanffy equation for growth.

A best case, an expected (average) case and a least case are shown in Tables 6 and 7. In Table 6, the number of days in the pond, along with stocking density and survival (among other factors), determines the size of shrimp at harvest. This, in turn, affects the price received per pound (kg). Based on the assumptions in Table 6, an economic analysis for the first year in a 10-year planning horizon for a 250-acre (101 ha) shrimp production unit is shown in Table 7.

The best case has a greater gross revenue than the other two cases because more pounds are produced per acre (1,055 versus 931 and 780), and a higher price per pound for shrimp is realized (\$5.43 versus \$4.80). The reason for the better results in the best case is that shrimp were grown in the ponds for 210 days versus 196 days (expected case) and 182 days (least case). Cost variances among the three cases are because of feed. All other cost items are the same or approximately the same. As a result, the best case yields substantially more net revenue after taxes than the other two cases.

To summarize, the results in Table 7 show the economic potential of shrimp culture along with the economic impact of shrimp growth on profit. A number of factors affect the profitability of shrimp culture op-

erations, including grow-out period, survival, growth rate and stocking density on the production side, and land and construction costs, production seedstock and feed, and fixed interest and depreciation costs on the cost side. Sensitivity analyses are underway to determine how changes in these parameters affect profit (36,1,34,42,83).

## Potential of Shrimp Culture

Shrimp culture is evolving into a new industry for both developed and developing countries. It represents an income source for new economic growth and development throughout the world. This is illustrated by the significant increase in the quantity of shrimp imported into the United States from two developing countries, Ecuador and Panama. Table 8 compares the imports from these countries with those from countries without significant shrimp mariculture development (74,75,76,77,78).

There has been a 40 percent increase in production of pond-grown shrimp in Ecuador each year since 1977, and, presently, 80 percent of all shrimp exported from Ecuador are farm-raised (4,37). Marine shrimp were the most valuable renewable resource in Ecuador in 1981, surpassing bananas, coffee and cacao, and were second only to oil in terms of total commodity exports (37). The tremendous increase in marine shrimp imported into the United States from Ecuador has occurred in the same period as a 20 percent decrease in

that country's commercial catch from natural sources (4).

Although shrimp has been the most valuable of U.S. fisheries for the past five years, nearly half of the shrimp consumed in this country is imported (Table 1). With no potential increase in shrimp harvested in the United States from natural sources and with the increasing quantity of imported shrimp required to satisfy consumer demands, it seems apparent that substantial amounts could be produced and marketed by U.S. shrimp culturists.

The long coastlines, coastal topography, soil composition and climate along the Gulf of Mexico and southern Atlantic coasts of the United States are all conducive to shrimp mariculture. For example, 70 to 90 percent of the land adjacent to the Texas coastline (2,000 to 2,500 miles or 3,218 to 4,023 km) has a soil composition adequate for shrimp mariculture (100). Much of this land is too salty for traditional agricultural crops such as cotton, grain sorghum or cattle. The temperature of the Texas coast is adequate for a five- to six-month growing season near the Beaumont-Port Arthur (Jefferson County) area. Moving south, the growing season is gradually increased, reaching a maximum of 6.5 to 7.5 months near the Brownsville-Port Isabel (Cameron County) area in South Texas. The length of this growing season is more than sufficient for at least one crop per year along the Gulf and southern Atlantic coasts, and it may support two crops per year in some locations (52).

The United States has a number of inland areas that could support shrimp culture operations. West Texas, for example, has millions of acres of land with seawater less than 50 feet underground. Mariculture development in this area also would provide the added benefit of a new agricultural crop since much of West Texas lacks sufficient fresh water for irrigation to sustain traditional crops.

At least three species of marine shrimp have been cultured in ponds at commercial levels in Alabama (102,103), Florida (21), Louisiana (15,48,81) and Texas (33,84,31,85,40,-22,95,51)(Table 9). By comparing these production levels with the potential profits shown in Table 6, the total economic impact on local, state and national levels is assumed to be approximately three times the producer level value. This assumption is based on economists' estimates that the total economic impact of the shrimp fisheries is about three times the ex-vessel value of the Gulf of Mexico catch. Thus, using the expected case as an example, the economic impact of only 250 acres (101 ha) of water could be approximately \$3,352,000.

The decreasing natural production of shrimp coupled with increasing consumer demand, the opportunity to reduce imports, the availability of suitable land, and the potential economic impact makes shrimp mariculture an important emerging industry in the United States. It is attracting investor attention because of the increasing level of technology and its commercial success in other countries such as Ecuador.

**Table 9: Culture of marine shrimp in ponds: state of the art**

Species ( <i>Penaeus</i> )	Production* (lbs/acre)	Heads on Count (no/lb)	Percent Survival
<b>P. vannamei</b>	600-2000	20-40	50-90
<b>P. stylirostris</b>	500-1200	20-40	30-70
<b>P. setiferus</b>	500-1200	25-40	30-40

*\*To obtain production in kg/ha multiply lbs/acre by 1.123.*

- <sup>1</sup>Adams, C.M., W.L. Griffin, J.P. Nichols and R.W. Brick. 1980. **Bio-engineering Economic Model for Shrimp Mariculture System**, 1979. Texas A&M University Sea Grant College Program Technical Report TAMU-SG-80-203. 125 pp.
- <sup>2</sup>Al-Attar, M.H. and H. Ikenoue. 1979. The production of juvenile shrimps (*Penaeus semisulcatus*) for release off the coast of Kuwait during 1975. **Kuwait Bulletin of Marine Science** 1:1-31.
- <sup>3</sup>Alikuhni, K.H., A. Poernomo, S. Adisukresno, M. Budiono and S. Busman. 1975. Preliminary observations on induction of maturing and spawning in *Penaeus monodon* Fabricius and *Penaeus merguensis* de Man by eyestalk extirpation. **Bulletin Shrimp Culture Research Center** (Pusat Penelitian Udan, Jeparo) 1:1-11.
- <sup>4</sup>Anonymous. 1982. Fishing exports now second largest. Pp. 148 to 156 in W.R. Spurrier (ed.), **Weekly Analysis of Ecuadorian Issues Number 18**.
- <sup>5</sup>Aquacop. 1975. Maturation and spawning in captivity of penaeid shrimp: *Penaeus merguensis* de Man, *Penaeus japonicus* Bates, *Penaeus aztecus* Ives, *Metapenaeus ensis* de Haan *Penaeus semiculatus* de Haan. **Proceedings World Mariculture Society** 6:123-132.
- <sup>6</sup>Aquacop. 1977. Reproduction in captivity and growth of *Penaeus monodon*, Fabricius in polynesia. **Proceedings World Mariculture Society** 8:927-945.
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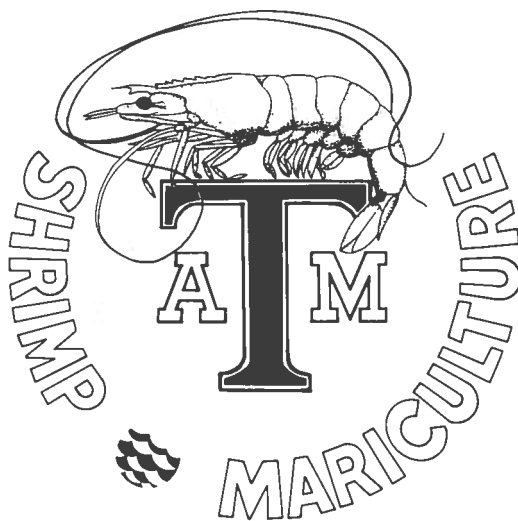
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